REMARKS

In response to the final Office Action dated August 27, 2002, the following arguments are presented. Claims 1-20 remain in the case. The Applicant respectfully requests that this response be entered under 37 C.F.R. 1.116 to place the above-referenced application in condition for allowance or, alternately, in better form for consideration on appeal. In light of the arguments set forth in this response, reexamination and reconsideration of the application are requested.

Section 103(a) Rejections

Sengupta et al. and Burkhardt et al. Patents

The final Office Action rejected claims 1, 2, 4, 6, 12-16, 19 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. (U.S. Patent No. 6,359,647) in view of Burkhardt et al. (U.S. Patent No. 4,631,598). The Office Action contended that Sengupta et al. disclose all elements of the Applicant's claimed invention except for disclosing data overlapping and time offset values for the transformation. However, the Office Action stated that Burkhardt et al. disclose such an approach to work in a high speed and variable resolution digital system.

In response, the Applicant respectfully traverses these rejections based on the following arguments and as supported by the attached declaration under 37 C.F.R. §1.132 of John C. Krumm. In particular, it is the Applicant's position that Sengupta et al. and Burkhardt et al. do not disclose or suggest at least one claimed feature of the Applicant's claimed invention. In addition, both Sengupta et al. and Burkhardt et al. do not provide any motivation for at least one claimed feature of the Applicant's claimed invention and fail to appreciate advantages of this claimed feature.

To make a prima facie showing of obviousness, each one of the claimed features of an Applicant's invention must be considered. This is especially true when the claimed features are missing from the prior art. If a claimed feature is not taught in the prior art and

has advantages not appreciated by the prior art, then no prima facie showing of obviousness has been made. The Federal Circuit Court has held that it was an error not to distinguish claims over a combination of prior art references where a material limitation in the claimed system and its purpose was not taught therein. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). Moreover, if the prior art references <u>do not disclose, suggest</u> or provide any motivation for at least one claimed feature of an Applicant's invention then a prima facie case of obviousness has not been established (MPEP § 2142).

Independent claim 1 of the Applicant's claimed invention includes a method of determining a relative position and orientation (a camera pose) between a base camera and a non-base camera. This relative position and orientation between a base camera and a non-base camera is the geometric calibration for each camera that determines the camera (or relative) pose. The method includes measuring a path of an object with the base camera, in a base coordinate frame, and measuring the object path with the non-base camera in a non-base coordinate frame. The method further includes calculating transformation parameters based on the object path and applying the transformation parameters to the object path measure with the non-base camera. The transformation parameters are applied such that the object path measured by the non-base camera (in the non-base coordinate frame) is expressed in the base coordinate frame. This base coordinate frame is the coordinate frame of the base camera.

In contrast, Sengupta et al., do not disclose the Applicant's claimed feature of calculating transformation parameters based on the object path to <u>compute a camera pose</u>. In fact, Sengupta et al. merely disclose a system that presupposes and assumes that the cameras contained in the system are already calibrated and that <u>the camera pose is already known</u>. This position of the Applicant is supported by the attached declaration under 37 C.F.R. §1.132 of John C. Krumm.

More specifically, Sengupta et al. discuss a multi-camera security system that comprises multiple video cameras (col. 3, lines 8-10). These cameras are positioned at

different locations around a room (FIG. 1; col. 3, lines 10-15). The system and multiple video cameras are used to determine and track an object as the "object traverses from one camera's field of view to another camera's field of view" (col. 3, lines 54-65). In order to determine a precise location of an object along a camera's line of sight, a ranging technique may be employed (col. 6, lines 14-16). Once the object's location (P in FIG. 5C) is determined, "the cameras within whose field of view the location P lies can be determined" (col. 7, lines 14-15). "This is because the cameras' fields of view are modeled in this same coordinate system" (col. 7, lines 16-17; emphasis added). In other words, the camera pose for each camera is already known.

Throughout the patent of Sengupta et al. there are passages that state a presupposed knowledge of the position and orientation (i.e., camera pose) of each camera. For example, the "field of view determinator 150 determines the field of view of each camera based upon its location and orientation" (col. 3, lines 38-39; emphasis added). The "approximate physical location of a figure is determined from the displayed image, the identification of the figure within this image by the figure tracking system, and a knowledge of the camera's location and actual field of view which is producing the displayed image" (col. 2, lines 4-8; emphasis added).

All of the above passages point to the fact that in Sengupta et al. the camera pose of each camera is already known. In fact, the "orientation of the camera, in the physical coordinate space, is determined when the camera is initially installed" (col. 9, lines 19-21; emphasis added). This data is stored in "a database 160 that describes the secured area and the location of each camera" (col. 3, lines 43-46; emphasis added). Sengupta et al. do not discuss how the camera pose is determined when each camera is initially installed, only that some calibration has occurred and that the results of that calibration are stored in a database. Thus, while the Applicant's claim a method for computing a camera pose by calculating transformation parameters, Sengupta et al. disclose a system that depends on the camera pose (camera location and orientation) being known. This position of the Applicant is supported by the attached declaration under 37 C.F.R. §1.132 of John C. Krumm.

In addition, Sengupta et al. fail to provide any <u>motivation, suggestion or desirability</u> to modify their system to calculate transformation parameters based on an object path and determine a camera pose. One reason for this is that the system in Sengupta et al. presupposes that the cameras are already calibrated. On the other hand, the Applicant's claimed invention is a calibration method for range cameras and determines camera pose. Absent any type of motivation or suggestion, therefore, Sengupta et al. cannot render the Applicant's claimed invention obvious (MPEP § 2143.01).

The Office Action maintains that FIGS. 6A and 6B of Sengupta et al. disclose the Applicant's claimed feature of calculating transformation parameters based on an object path. However, a careful reading of Sengupta et al. reveals that FIG. 6A and 6B do not disclose calculating transformation parameters based on an object path. In fact, FIG. 6A of Sengupta et al. merely discusses determining a location of a target in a room. This location is determined along a camera's line of sight (LOS) either by ranging or interpolation (col. 9, lines 29-31). Once the location of the target along the line of sight is determined, the target's location in the room is determined. For ranging, this location is at the point along the LOS at a distance R from the camera's location (col. 9, lines 33-16). For interpolation, this location is at an intersection point of a first camera's line of sight (LOS1) and a second camera's line of sight (LOS2). Unlike the Applicant's claimed invention, however, nowhere are transformation parameters calculated based on an object path because the camera pose for each camera is already known.

FIG. 6B of Sengupta et al. merely discusses identifying and selecting a camera such that the target is contained within the selected camera's field of view (col. 9, lines 52-57). This "process merely comprises a determination of whether point P lies within the polygon or polyhedron" associated with each camera (col. 9, lines 59-61). Nowhere do Sengupta et al. discuss calculating transformation parameters based on an object path because the camera pose for each camera is already known.

Burkhardt et al. add nothing to the cited combination that would render the Applicant's claimed invention obvious. Burkhardt et al. merely disclose a system and a method for high-speed, high-resolution scanning of documents (col. 2, lines 7-9). The Applicant's feature of calculating transformation parameters based on an object path is not discussed. Consequently, no motivation or suggestion for this feature of the Applicant's invention is provided. Absent this motivation or suggestion, Burkhardt et al. cannot render the Applicant's claimed invention obvious (MPEP § 2143.01).

Sengupta et al. and Burkhardt et al. both fail to appreciate or recognize the advantages of the Applicant's claimed feature of calculating transformation parameters based on an object path. Specifically, in order for multiple range cameras to work together in a system, "the cameras must be calibrated to determine a position and an orientation of each camera relative to one of the cameras (known as a relative pose). This calibration of multiple cameras enables the ranging system to convert 3-D measurements obtained from each camera into a common coordinate frame" specification, page 2, lines 6-11). "Several types of manual calibration techniques are used to calibrate the range cameras. One type of calibration technique uses a three-dimensional calibration chart to determine the relative position of each camera. This technique, however, is difficult to use and time-consuming because it requires that the calibration chart be positioned correctly within a scent" (specification, page 2, lines 15-20). "Another type of calibration technique requires a user to monitor a scene and determine a plurality of reference points in the scene until the relative position of each camera can be determined" (specification, page 2, lines 21-23). One disadvantage, however, of this technique is that it is a "complicated and time-consuming calibration process" (specification, page 2, lines 26-29). On the other hand, the Applicant's claimed technique of calibrating multiple cameras by calculating transformation parameters based on an object path simplifies and shortens the calibration process. Neither Sengupta et al. nor Burkhardt et al. discuss or appreciate these advantages of the Applicant's claimed feature of calculating transformation parameters based on an object path.

Independent claim 12 also includes the feature of calculating a transformation parameter using a time offset value. In addition, independent claim 19 also includes the feature of calculating a transformation parameter that causes a first observed object path to approximately overlap with a second observed object path. As discussed above, neither Sengupta et al. nor Burkhardt et al. discuss calculating a transformation parameter, either based on an object path, using a time offset value, or causing overlap of two object paths. Moreover, neither Sengupta et al. nor Burkhardt et al. appreciate the advantages of this claimed feature.

The Applicant, therefore, submits that obviousness cannot be established since neither Sengupta et al. nor Burkhardt et al. disclose, suggest or provide any motivation for the Applicant's claimed feature of calculating transformation parameters based on an object path, using a time offset value, or causing overlap of two object paths. In addition, both Sengupta et al. and Burkhardt et al. fail to appreciate advantages of this claimed feature. Therefore, as set forth in *In re Fine* and MPEP § 2142, Sengupta et al. and Burkhardt et al., either alone or in combination, do not render the Applicant's claimed invention obvious because these patents are missing at least one material feature of the Applicant's invention. Consequently, because a prima facie case of obviousness cannot be established due to the lack of "some teaching, suggestion, or incentive supporting the combination", the rejections must be withdrawn. ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984); MPEP 2143.01.

Accordingly, the Applicant respectfully submits that claims independent claims 1, 12 and 19 are patentable under 35 U.S.C. § 103(a) over Sengupta et al. in view of Burkhardt et al. based on the arguments set forth above and below. Moreover, claims 2, 4 and 6 depend from independent claim 1, claims 13-16 depend from independent claim 12, and claim 20 depends from independent claim 19 and are also nonobvious over Sengupta et al. in view of Burkhardt et al. (MPEP § 2143.03). The Applicant, therefore, respectfully requests reexamination, reconsideration and withdrawal of the rejection of claims 1, 2, 4, 6, 12-16, 19 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al.

in view of Burkhardt et al..

Sengupta et al. and Takayama et al. Patents

The Office Action rejected claims 3 and 5 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Takayama et al. (U.S. Patent No. 6,138,196). The Office Action contended that Sengupta et al. disclose all elements of the Applicant's claimed invention except for performing data matching point. However, the Office Action stated that Takayama et al. disclose such an approach to use in various types of digital interface systems.

In response, the Applicant respectfully traverses these rejections based on the following arguments. In particular, Sengupta et al. and Takayama et al. do not disclose or suggest at least one claimed feature of the Applicant's claimed invention. Further, both Sengupta et al. and Takayama et al. do not provide any motivation for at least one claimed feature of the Applicant's claimed invention and also fail to appreciate advantages of this claimed feature.

As discussed above, independent claim 1 of the Applicant's claimed invention includes a method of determining a relative position and orientation between a base camera and a non-base camera. The method of determining camera (or relative) pose includes calculating transformation parameters based on the object path and applying the transformation parameters to the object path measure with the non-base camera.

In contrast, Sengupta et al. do not discuss transformation parameters but merely discuss a security camera system that presupposes that the cameras are calibrated and that each camera pose is known.

Takayama et al. add nothing to the cited combination that would render the Applicant's claimed invention obvious. Takayama et al. merely disclose a method of communicating between nodes of electronic equipment using a serial bus interface (Abstract, lines 1-2). This method in Takayama et al. includes using a serial bus interface,

electronic equipment for digital data transfer using the interface, and a control device for controlling the data transfer (col. 1, lines 16-19). However, a careful reading of Takayama et al. indicates that Takayama et al. does not discuss the Applicant's claimed feature of calculating transformation parameters based on the object path. In fact, Takayama et al. do not even discuss transformation parameters or camera pose. Consequently, no motivation or suggestion for this feature of the Applicant's invention is provided. Absent this motivation or suggestion, Takayama et al. cannot render the Applicant's invention obvious (MPEP § 2143.01).

Sengupta et al. and Takayama et al. both fail to appreciate or recognize the advantages of the Applicant's claimed feature of calculating transformation parameters based on an object path. Specifically, Takayama et al. do not discuss how calculating transformation parameters based on an object path simplifies and shortens the calibration process.

The Applicant, therefore, submits that obviousness cannot be established since neither Sengupta et al. nor Takayama et al. disclose, suggest or provide any motivation for the Applicant's claimed feature of calculating transformation parameters based on an object path. In addition, both Sengupta et al. and Takayama et al. fail to appreciate advantages of this claimed feature. Therefore, as set forth in *In re Fine* and MPEP § 2142, Sengupta et al. and Takayama et al., either alone or in combination, do not render the Applicant's claimed invention obvious because these patents are missing at least one material feature of the Applicant's invention. Consequently, because a prima facie case of obviousness cannot be established due to the lack of "some teaching, suggestion, or incentive supporting the combination", the rejections must be withdrawn. ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984); MPEP 2143.01.

Accordingly, the Applicant respectfully submits that claims independent claim 1 is patentable under 35 U.S.C. § 103(a) over Sengupta et al. in view of Takayama et al. based on the arguments set forth above and below. Moreover, claims 3 and 5 depend

from independent claim 1 and are also nonobvious over Sengupta et al. in view of Takayama et al. (MPEP § 2143.03). The Applicant, therefore, respectfully requests reexamination, reconsideration and withdrawal of the rejection of claims 3 and 5 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Takayama et al..

Sengupta et al. and Thompson et al. Patents

The Office Action rejected claims 7-9, 17 and 18 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Thompson et al. (U.S. Patent No. 5,764,516). The Office Action contended that Sengupta et al. disclose all elements of the Applicant's claimed invention except for a least squares solution and least median of squares solution error minimization technique. The Office Action, however, stated that Thompson et al. disclose such an approach for phase correction on a multiple frequency bands system.

In response, the Applicant respectfully traverses these rejections based on the following arguments. In particular, Sengupta et al. and Thompson et al. do not <u>disclose or suggest</u> at least one claimed feature of the Applicant's claimed invention. Further, both Sengupta et al. and Thompson et al. do not provide any motivation for at least one claimed feature of the Applicant's claimed invention and fail to appreciate advantages of this claimed feature.

As discussed above, independent claim 1 of the Applicant's claimed invention includes a method of determining a relative position and orientation between a base camera and a non-base camera. The method includes calculating transformation parameters based on the object path and applying the transformation parameters to the object path measure with the non-base camera. As also mentioned above, Sengupta et al. neither discuss calculating transformation parameters (since it is assumed that the cameras are already calibrated) nor appreciate their advantages.

Thompson et al. add nothing to the cited combination that would render the Applicant's claimed invention obvious. Thompson et al. disclose a system and method for correcting seismic data for phase distortion (Abstract, lines 1-3). Thompson et al.,

however, do not discuss the Applicant's claimed feature of calculating transformation parameters based on the object path (as in independent claim 1) or using time offset value (as in independent claim 12). Consequently, no motivation or suggestion for this feature of the Applicant's invention is provided. Absent this motivation or suggestion, Thompson et al. cannot render the Applicant's invention obvious (MPEP § 2143.01).

Thompson et al. also fail to appreciate or recognize the advantages of the Applicant's claimed feature of calculating transformation parameters based on an object path or using a time offset value. Specifically, Thompson et al. do not discuss how calculating transformation parameters based on an object path or using a time offset value simplifies and shortens the calibration process of a range camera.

The Applicant, therefore, submits that obviousness cannot be established since neither Sengupta et al. nor Thompson et al. disclose, suggest or provide any motivation for the Applicant's claimed feature of calculating transformation parameters based on an object path or using a time offset value. In addition, both Sengupta et al. and Thompson et al. fail to appreciate any advantages of this claimed feature. Therefore, as set forth in *In re Fine* and MPEP § 2142, Sengupta et al. and Thompson et al., either alone or in combination, do not render the Applicant's claimed invention obvious because these patents are missing at least one material feature of the Applicant's claimed invention. Consequently, because a prima facie case of obviousness cannot be established due to the lack of "some teaching, suggestion, or incentive supporting the combination", the rejections must be withdrawn. <u>ACS Hospital Systems, Inc. v. Montefiore Hospital</u>, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984); MPEP 2143.01.

Accordingly, the Applicant respectfully submits that claims independent claims 1 and 12 are patentable under 35 U.S.C. § 103(a) over Sengupta et al. in view of Thompson et al. based on the arguments set forth above and below. Moreover, claims 7-9 depend from independent claim 1, and claim 17 and 18 depend from independent claim 12 and are also nonobvious over Sengupta et al. in view of Thompson et al. (MPEP § 2143.03). The Applicant, therefore, respectfully requests reexamination, reconsideration and

withdrawal of the rejection of claims 7-9, 17 and 18 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Thompson et al..

Sengupta et al. and Grumet et al. Patents

The Office Action rejected claims 10 and 11 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Grumet et al. (U.S. Patent No. 4,490,849). The Office Action contended that Sengupta et al. disclose all elements of the Applicant's claimed invention except for correction of unsynchronized data between cameras. The Office Action, however, stated that Grumet et al. disclose such an approach for an optical matched image correlation system.

In response, the Applicant respectfully traverses these rejections based on the following arguments. In particular, Sengupta et al. and Grumet et al. do not disclose or suggest for at least one claimed feature of the Applicant's claimed invention. Further, both Sengupta et al. and Grumet et al. do not provide any motivation for at least one claimed feature of the Applicant's claimed invention and fail to appreciate advantages of this claimed feature.

As discussed above, independent claim 1 of the Applicant's claimed invention includes a method of determining a relative position and orientation between a base camera and a non-base camera. The method includes calculating transformation parameters based on the object path and applying the transformation parameters to the object path measure with the non-base camera. Sengupta et al., as discussed above, neither discuss calculating transformation parameters nor appreciate their advantages.

Grumet et al. add nothing to the cited combination that would render the Applicant's claimed invention obvious. Grumet et al. disclose a system and method for processing a digital signal using an optical match filter (col. 2, lines 6-10). Grumet et al., however, do not discuss the Applicant's claimed feature of calculating transformation parameters based on the object path. Thus, no motivation or suggestion for this feature of the Applicant's invention is provided. Absent this motivation or suggestion, Grumet et al. cannot render

the Applicant's claimed invention obvious (MPEP § 2143.01).

Grumet et al. also fail to appreciate or recognize the advantages of the Applicant's claimed feature of calculating transformation parameters based on an object path. In particular, Grumet et al. do not discuss how calculating transformation parameters based on an object path simplifies and shortens the process of calibrating a range camera.

The Applicant, therefore, submits that obviousness cannot be established since neither Sengupta et al. nor Grumet et al. disclose, suggest or provide any motivation for the Applicant's claimed feature of calculating transformation parameters based on an object path. In addition, both Sengupta et al. and Grumet et al. fail to appreciate any advantages of this claimed feature. Thus, as set forth in *In re Fine* and MPEP § 2142, Sengupta et al. and Grumet et al., either alone or in combination, do not render the Applicant's claimed invention obvious because these patents are missing at least one material feature of the Applicant's invention. Consequently, because a prima facie case of obviousness cannot be established due to the lack of "some teaching, suggestion, or incentive supporting the combination", the rejections must be withdrawn. ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984); MPEP 2143.01.
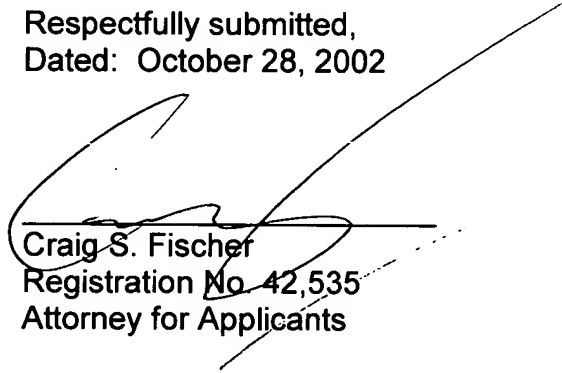
Accordingly, the Applicant respectfully submits that claims independent claim 1 is patentable under 35 U.S.C. § 103(a) over Sengupta et al. in view of Grumet et al. based on the arguments set forth above. Moreover, claims 10 and 11 depend from independent claim 1 and are also nonobvious over Sengupta et al. in view of Grumet et al. (MPEP § 2143.03). The Applicant, therefore, respectfully requests reexamination, reconsideration and withdrawal of the rejection of claims 10 and 11 under 35 U.S.C. § 103(a) as being unpatentable over Sengupta et al. in view of Grumet et al..

In view of the arguments and amendments set forth above, the Applicant submits that claims 1-20 of the subject application are in immediate condition for allowance.

The Examiner is respectfully requested to withdraw the outstanding rejections of the claims and to pass this application to issue.

In an effort to expedite and further the prosecution of the subject application, the Applicant kindly invites the Examiner to telephone the Applicant's attorney at (805) 278-8855 if the Examiner has any comments, questions or concerns.

Respectfully submitted,
Dated: October 28, 2002

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PATENT TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: KRUMM

Serial No.: 09/543,235

Filed: April 5, 2000

For: RELATIVE RANGE CAMERA CALIBRATION

Group Art Unit: 2863

Examiner: T. Lau

DECLARATION UNDER 37 C.F.R. §1.132

Hon. Commissioner for Patents
Washington, D.C. 20231

Sir:

I, John C. Krumm, declare that I received a Ph.D. in Robotics from
Carnegie Mellon University in 1993, with a thesis on texture analysis in comput r
vision. From 1994-1997, I was employed in the Intelligent Systems and Robotics
Center at Sandia National Laboratory where I concentrated primarily on

computer vision for recognizing objects and reconstructing three-dimensional images from ultrasound scans of humans. I am currently employed by Microsoft Corporation, of Redmond, Washington, in Microsoft Research as a researcher in the Adaptive Systems and Interaction Group on working on sensing and computer vision for intelligent environments. In addition, I am the sole inventor of the subject patent application.

I further declare that:

I am familiar with United States Patent No. 6,359,647, hereinafter referred to as the Sengupta et al. patent. The Sengupta et al. patent discloses a multi-camera security system that tracks a figure in a multiple-camera environment. As the figure moves through the potential field-of-view of different cameras the system determines which camera to handoff to from the current camera. In this manner, the system of Sengupta et al. selects and adjusts the next camera based on the predicted subsequent location of the figure.

The system of Sengupta et al. presupposes that the cameras used therein are calibrated. In other words, Sengupta et al. assume that the camera pose or geometric calibration (the location and angle) of each camera is already known. Sengupta et al. perform this calibration to determine "[T]he orientation of the camera, in the physical coordinate space, . . .when the camera is initially installed" (col. 9, lines 19-21). This calibration information is stored in a database 160 "that describes the secured area and the location of each camera" (col. 3, lines 43-46).

By way of example, suppose that two cameras are used in the system of Sengupta et al. and that there is a reference coordinate system. An initialization and calibration is performed when the camera is initially installed to find out a camera's location and orientation (or pose). This data then is stored in a database. Based on this calibration, position data from each camera can be transformed into the reference coordinate system. Although Sengupta et al. do not discuss how the calibration is performed, they do presuppose that this calibration and transformation is already known.

On the other hand, the subject patent application claims a method and a system that calculates transformation parameters (i.e. calibrates the camera) based on the path of an object. In other words, the claimed invention computes a camera pose. Unlike the claimed invention contained in the subject patent application that claims a method for computing the camera poses, Sengupta et al. merely disclose a system that depends on already knowing the camera pose.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and further these statements were made with the knowledge that willful false statements and

the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: Oct. 23, 2002   Signed: _John C. Krumm_

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